Forage Production

Integration of Forage in Farming Systems

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Introduction

As more knowledge is acquired on forage crop growth, harvest and use, there is an increasing need to study the crop in an integrated farming system. Forage crops are interrelated to many other parts of the farm by the flow of material and nutrients, the scheduling of operations and the priority for use of limited available funds. Animal based farming systems must be developed that have all components working together to provide profitable and sustainable food production. The growing concern over environmental impacts of farms also brings greater need to study the whole farm and its relationship to the environment. This work reviews various topics related to forage production in an integrated farming system. Direction is provided for future research to fill information gaps and modeling needs for better analysis of forages in a whole farm context.

Materials and Methods

In a crop production system, forage is grown and sold as a marketable product in conjunction with other crops. Most forage is marketed as animal feed, but opportunities exist for other uses such as industrial processing and biomass energy. Regardless of the end use, the same basic crop production system is used. Forage is linked with other crops on the farm by their individual effects on soil structure and composition and the scheduling of operations according to available machinery, labor, and suitable weather.

Animal production normally includes crop production along with feeding, animal, and manure handling components. Crops, particularly forage, are primarily produced to feed the animals. Excess crops are marketed, and supplemental feeds are purchased to meet the nutrient requirements of the animals. Feeding is linked with other components of forage production by the form, particle size, and nutrient content of the forage. Supplemental feed must be properly combined with available forage to meet the animal's requirements.

Forages produced in farming systems must be evaluated with a systematic approach. All aspects of crop production and use must be viewed in relation to one another. This approach normally leads to modeling. Models can range from pictorial diagrams and simple accounting procedures to complex numerical models that simulate farming systems on a computer. Comprehensive models available today provide excellent research tools that enable better understanding of the role of forages in farming systems. In the future, these models also may be used for better management of forage systems.

Results and Discussion

Much work has focused on modeling and analysis of forage crops in animal production systems. This work has studied either grazing systems or conserved forage systems with little work including both options on the same farm. Grazing models primarily have been applied to beef production in the US, UK, and Australia. Conserved forage system models have been developed to study dairy production in the US, Canada, and Northern Europe.

Models serve three major functions: research, teaching, and management aids. Each of these functions has different goals or requirements, which generally prevent one model from serving all three functions. Until now, most forage system models were developed and used as research tools to generate information on forages in integrated farming systems. Opportunity for further development of these research aids exists. Major areas for more work include 1) integration of forages in cropping system models that evaluate production benefits along with externality costs to society, 2) integration of more crop options

along with forages in animal production system models, and 3) integration of grazing and conserved forage systems in a more comprehensive animal production model.

Teaching aids are models that can be used alone or in a classroom or workshop to illustrate the complexity of the production system and the impact of technological or management changes. Research aids provide good teaching aids if the effort is given to creating models that are easily used by others. Few models have taken this step, but this is likely to change over the next few years. Computer technology is now available for developing extensive, but intuitive, user interfaces for models.

Many models were developed with the promise of providing management aids for producers, yet few have reached this level of practical application. Comprehensive models that provide good research tools are generally too complex for application by a general audience. Although a good teaching aid can provide useful information for decision making, training of the user is required to insure that the model is used properly and thus provides reliable information. Management aids that integrate forages in farming systems will be developed in the future, but these may not come quickly. A different modeling approach such as an expert system is needed where comprehensive models or information generated by those models are used as experts in the decision making process. Expert system models are now used in forage crop management, but more development is needed for comprehensive management of an integrated multiple crop and animal production system.

Information gaps exist for the development of all three types of models. This begins with the crop. Most available forage crop models do not adequately predict developmental stages of the growing plant and the effect of stage on nutritive content. Much more information is also needed to better predict forage utilization by ruminants. Available animal models perform adequately when predicting intake and performance for well balanced diets. There is a growing need, however, to be able to predict intake and performance when the availability or nutritive characteristics of feeds is limiting animal response. This is particularly true under grazing conditions where animals tend to select plant material and feed supplements may not be available. The recycling of manure nutrients is another area where information is lacking. These include nutrient losses during handling and application, and the transport and transformation of nutrients in the soil profile. A relatively new and unexplored area of need is in quantifying the effects of farm losses on the environment and the societal cost for dealing with those effects.

Conclusion

Opportunities for further research on forages in cropping systems include basic and applied research on system components as well as modeling and analysis of complete farm systems. Regardless of experience and training, those with an interest in contributing to the effort of evaluating forages in cropping systems can find a place to apply their expertise.